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Wetting of bio-inspired, stimulus-responsive polymer surfaces by lipid vesicles

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The design of adaptive interlayers between synthetic substrates and soft biological matter is a cross-disciplinary challenge. In analogy to wetting of simple liquids on a solid substrate, one can tailor the adhesion of a cell model (lipid vesicle) by designing the substrate interactions, and the free energy of contact between the substrate and the biological object influences the shape of the vesicle. Similar to the shape of liquid drops on substrates, the shape of a vesicle is dictated by the enclosed volume, the membrane-substrate interactions, and the properties of a lipid bilayer characterized by tension and bending rigidity.
By uniting the experimental and theoretical expertise of our two groups, we investigate the static and dynamic wetting of lipid vesicles on bio-inspired, stimulus-responsive polymer brushes. As the polymer brush systems, we designed bio-inspired polymer brushes that selectively capture divalent heavy metal ions by the multivalent binding to thiol and carboxyl side chains. After confirming the collapse of polymer brushes in the presence of heavy metal ions, the wetting interaction between vesicles and the collapsed/swollen brushes was studied by (i) monitoring the height fluctuation of vesicles using interference contrast microscopy and (ii) analyzing the contact angles using confocal fluorescence microscopy. The change in brush conformation with (collapsed) and without ions (swollen) was utilized to parameterize the non-bonded interactions in the simulation model.
On the theoretical side, we are developing and implementing a numerical model of a vesicle on a substrate that accounts for the (i) bending rigidity of the lipid membrane, (ii) the interface potential between the solid substrate and membrane, and (iii) the buoyancy of the vesicle. Both, axially symmetric shapes that minimize the free energy as well as fluctuating, triangulated vesicles will be investigated and compared to experiments. Similarities and differences to the wetting of liquid droplets will be highlighted.

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